

CLAIMS

1. An enzyme-based monitoring device for monitoring the thermal impact of thermal processing on an object, characterized in that the said device  
5 comprises a sealed container enclosing a solid dehydrated mix comprising at least one enzyme and at least one first filler, sealing of the sealed container being obtained by means of at least one moisture vapor barrier.
2. An enzyme-based monitoring device according to claim 1, wherein the water  
10 content of the said solid dehydrated mix is below about 0.6% by weight.
3. An enzyme-based monitoring device according to claim 1 or claim 2, characterized in that said at least one enzyme represents between 0.001 and 10% by weight, of the solid dehydrated mix enclosed in the said sealed  
15 container.
4. An enzyme-based monitoring device according to any of claims 1 to 3, characterized in that said at least one first filler represents between 90 and 99.999 % by weight of the solid dehydrated mix enclosed in the said sealed  
20 container.
5. An enzyme-based monitoring device according to any of claims 1 to 4, characterized in that the said at least one first filler is a non-porous filler.
- 25 6. An enzyme-based monitoring device according to any of claims 1 to 5, characterized in that the said at least one first filler is an inorganic filler.
7. An enzyme-based monitoring device according to any of claims 1 to 6, characterized in that the said at least one first filler is selected from the group  
30 consisting of glass beads, metal beads and silica beads.

8. An enzyme-based monitoring device according to any of claims 1 to 5,  
characterized in that the said at least one first filler is an organic filler.
9. An enzyme-based monitoring device according to any of claims 1 to 5,  
5 characterized in that the said at least one first filler consists of polymer beads.
10. An enzyme-based monitoring device according to any of claims 1 to 9,  
characterized in that the said first filler consists of beads with an average size  
below about 0.3 mm.
- 10 11. An enzyme-based monitoring device according to any of claims 1 to 10,  
characterized in that the said solid dehydrated mix further comprises at least  
one second filler.
- 15 12. An enzyme-based monitoring device according to claim 11, characterized in  
that the said at least one second filler represents up to 10 %, preferably up to  
5%, by weight of the solid dehydrated mix enclosed in the said sealed  
container.
- 20 13. An enzyme-based monitoring device according to claim 11 or claim 12,  
characterized in that the said at least one second filler is a water-soluble filler.
14. An enzyme-based monitoring device according to any of claims 11 to 13,  
characterized in that the said at least one second filler is an organic filler.
- 25 15. An enzyme-based monitoring device according to any of claims 11 to 14,  
characterized in that the said at least one second filler is selected from the  
group consisting of polyols and carbohydrates.
- 30 16. An enzyme-based monitoring device according to any of claims 11 to 13,  
characterized in that the said at least one second filler is an inorganic filler.

17. An enzyme-based monitoring device according to claim 16, characterized in that the said at least one second filler is selected from the group consisting of alkali and alkaline-earth metal salts.
- 5 18. An enzyme-based monitoring device according to any of claims 1 to 17, characterized in that the said enzyme is from bacterial, vegetal, animal or fungal origin.
19. An enzyme-based monitoring device according to any of claims 1 to 18,  
10 characterized in that the said enzyme is a bacterial  $\alpha$ -amylase.
20. An enzyme-based monitoring device according to any of claims 1 to 18, characterized in that the said enzyme is a pectin methyl esterase.
- 15 21. An enzyme-based monitoring device according to any of claims 1 to 20, characterized in that the amount of the at least one enzyme in the device is below about 3 mg.
22. An enzyme-based monitoring device according to any of claims 1 to 21,  
20 characterized in that the sealed container is made from one or more moisture-impermeable materials selected from the group consisting of glass, silica, metals and polymers.
23. An enzyme-based monitoring device according to any of claims 1 to 22,  
25 characterized in that the sealed container is made from one or more layers.
24. An enzyme-based monitoring device according to any of claims 1 to 23, characterized in that the container is sealed in such a way as to prevent that the moisture content of the solid dehydrated mix enclosed within the said  
30 container exceeds about 0.6% by weight of the said mix.

25. Use of a solid dehydrated mix comprising at least one enzyme and at least one first filler as a bio-integrator for monitoring the thermal processing of an object within a temperature range from about 60°C to 160°C.
- 5 26. Use according to claim 25, wherein the said object is in a particulate form.
27. Use according to claim 25 or claim 26, wherein the said object is human or animal food.
- 10 28. Use according to claim 25, wherein the said object is a medical tool or device.
29. Use according to claim 25, wherein the said object is a pharmaceutical composition in the form of a liquid, syrup, cream or paste.
- 15 30. Use according to any of claims 25 to 29, wherein monitoring is based on residual enzymatic activity after said thermal processing.
31. Use according to any of claims 25 to 30, in the form of a process step in a pasteurization or sterilization process.
- 20 32. Use according to any of claims 25 to 31, wherein the water content of the said solid dehydrated mix is below about 0.6% by weight.
33. Use according to any of claims 25 to 32, wherein the said at least one enzyme represents between 0.001 and 10% by weight, of the solid dehydrated mix.
- 25 34. Use according to any of claims 25 to 33, wherein said at least one first filler represents between 90 and 99.999 % by weight of the solid dehydrated mix.
- 30 35. Use according to any of claims 25 to 34, wherein the said at least one first filler is a non-porous filler.

36. Use according to any of claims 25 to 35, wherein the said at least one first filler is an inorganic filler.
- 5 37. Use according to any of claims 25 to 36, wherein the said at least one first filler is selected from the group consisting of glass beads, metal beads and silica beads.
- 10 38. Use according to any of claims 25 to 35, wherein the said at least one first filler is an organic filler.
39. Use according to any of claims 25 to 35, wherein the said at least one first filler consists of polymer beads.
- 15 40. Use according to any of claims 25 to 39, wherein the said first filler consists of beads with an average size below about 0.3 mm.
41. Use according to any of claims 25 to 40, wherein the said solid dehydrated mix further comprises at least one second filler.
- 20 42. Use according to claim 41, wherein the said at least one second filler represents up to 10 %, preferably up to 5%, by weight of the solid dehydrated mix.
- 25 43. Use according to claim 41 or claim 42, wherein the said at least one second filler is a water-soluble filler.
44. Use according to any of claims 41 to 43, wherein the said at least one second filler is an organic filler.
- 30 45. Use according to any of claims 41 to 44, wherein the said at least one second filler is selected from the group consisting of polyols and carbohydrates.

46. Use according to any of claims 41 to 43, wherein the said at least one second filler is an inorganic filler.
- 5 47. Use according to any of claims 41 to 43, wherein the said at least one second filler is selected from the group consisting of alkali and alkaline-earth metal salts.
48. Use according to any of claims 25 to 47, wherein the said enzyme is from bacterial, vegetal, animal or fungal origin.
- 10 49. Use according to any of claims 25 to 48, wherein the said enzyme is a bacterial  $\alpha$ -amylase.
- 15 50. Use according to any of claims 25 to 48, wherein the said is a pectin methyl esterase.
51. Use according to any of claims 25 to 50, wherein the amount of the at least one enzyme in the solid dehydrated mix is below about 3 mg.
- 20 52. Use according to any of claims 25 to 51, wherein the said solid dehydrated mix is enclosed in a sealed container.
53. A method of monitoring the thermal impact of thermal processing on an object by means of an enzyme-based monitoring device comprising a sealed  
25 container enclosing a solid dehydrated mix comprising at least one enzyme and at least one first filler, sealing of the sealed container being obtained by means of at least one moisture vapor barrier, the said method comprising the steps of:
- 30 (a) placing the enzyme-based monitoring device in contact with the said object or in the neighbourhood of the said object;

- 5 (b) exposing said object and said enzyme-based monitoring device to thermal processing at a temperature within a range from about 60°C to about 140°C for sufficient time for degrading a substantial portion of enzymes present at the surface or in the neighbourhood of the said object without breaking the moisture vapor barrier of the sealed container;
- (c) removing said sealed container from contact with the said object or from the neighbourhood of the said object after completion of step (b);
- (d) opening the said sealed container and obtaining a sample of the at least one enzyme from the said sealed container;
- 10 (e) measuring the residual activity of the said at least one enzyme in the sample so obtained, and
- (f) using the measured residual activity as a means to quantify the thermal impact of the thermal processing of step (b) on one or more given target attributes of the said object.

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54. A method of monitoring the thermal impact of thermal processing on an object according to claim 53, characterized in that :

- in step (d), a sample of the at least one enzyme enclosed in the said sealed container is obtained in the form of an enzyme solution by solubilizing in or more solvents the fraction of said solid dehydrated mix comprising the said at least one enzyme, and
- 20 - in step (e) the said enzyme solution is put into contact with a substrate for the said at least one enzyme, resulting in a product, and measuring the residual activity of the said at least one enzyme is effected by quantifying
- 25 the rate of formation of the said product.

55. A method of monitoring the thermal impact of thermal processing on an object according to claim 53 or claim 54, characterized in that the said given target attribute of the said object being quantified in step (f) is a chemical, physical, organoleptic or microbiological property of the said object.

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56. A method of monitoring the thermal impact of thermal processing on an object according to any of claims 53 to 55, wherein the said object is human or animal food.
- 5 57. A method of monitoring the thermal impact of thermal processing on an object according to any of claims 53 to 55, wherein the said object is a medical tool or device.
- 10 58. A method of monitoring the thermal impact of thermal processing on an object according to any of claims 53 to 55, wherein the said object is a pharmaceutical composition in the form of a liquid, syrup, cream or paste.
- 15 59. A method of monitoring the thermal impact of thermal processing on an object according to any of claims 53 to 58, wherein the said thermal processing is part of a pasteurization or sterilization process.
- 20 60. A method of monitoring the thermal impact of thermal processing on an object according to any of claims 53 to 59, wherein the said at least one enzyme represents between 0.001 and 10% by weight, of the solid dehydrated mix.
- 25 61. A method of monitoring the thermal impact of thermal processing on an object according to any of claims 53 to 60, wherein the water content of the said solid dehydrated mix is below about 0.6% by weight.
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